Energy Surety Approaches for Military Applications

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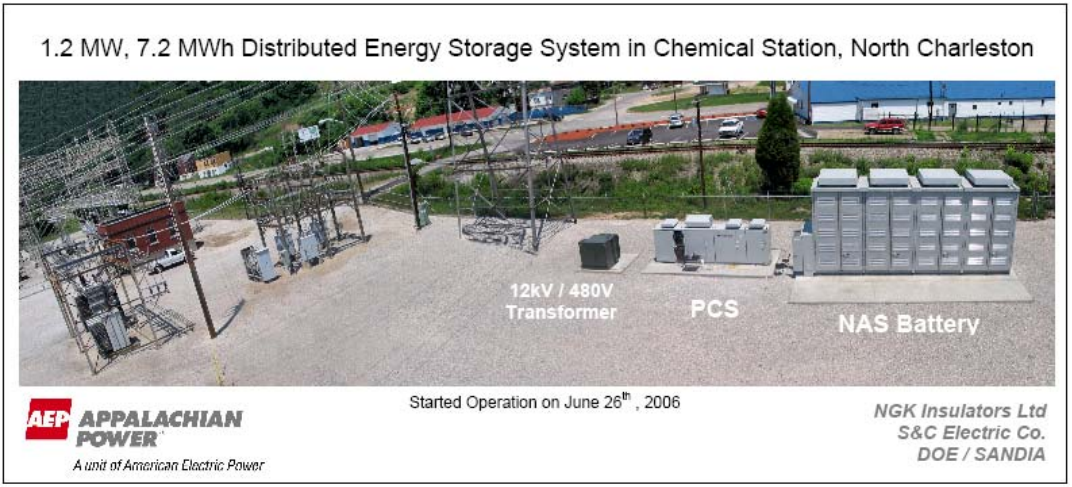
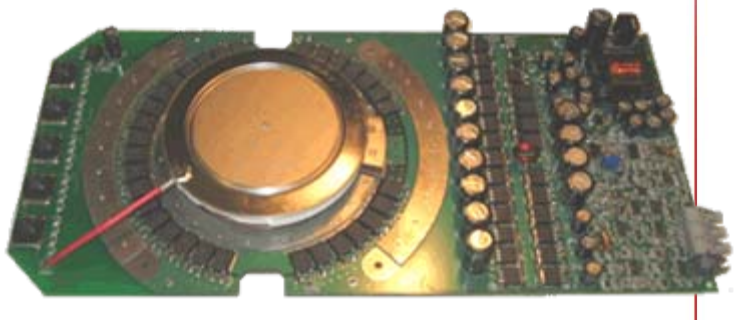
Energy Infrastructure and Distributed Energy Resources

S&C Purewave UPS System

- Distributed energy resources
- Power electronics
- Energy storage
- Energy Surety Microgrid



Application of Energy Storage



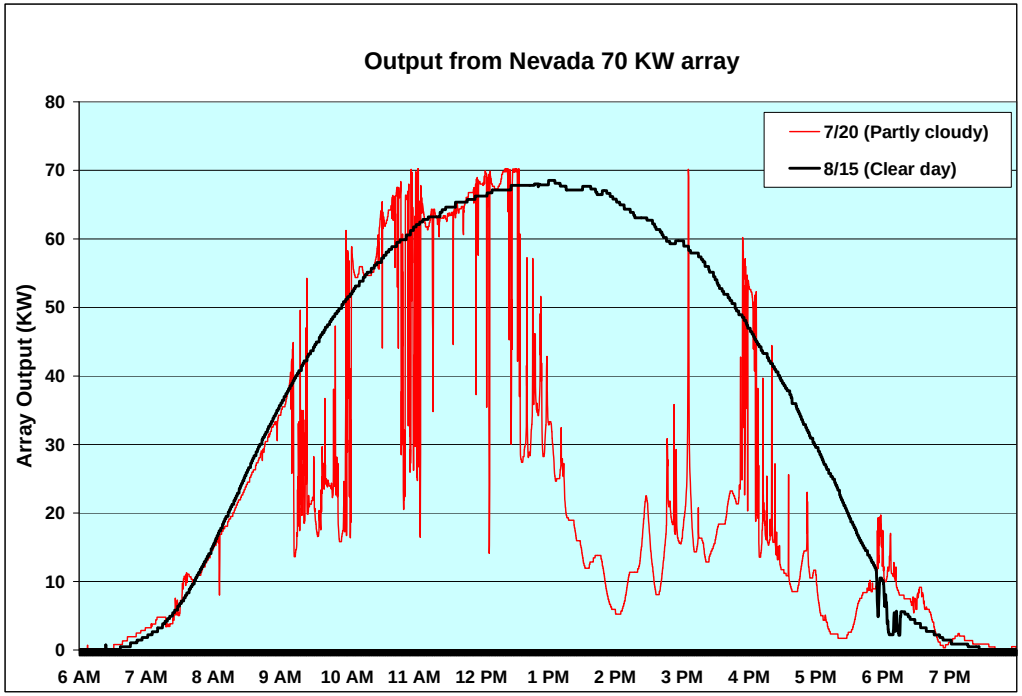
R&D 100: ETO High Power Switch

Sandia Manages the DOE Energy Storage Systems Program

Mission – Develop electrical energy storage systems for utility scale applications

Applications

- Peak Shaving
- Increase Asset Utilization
- Power Quality
- Voltage and Frequency Regulation
- Renewable Integration
- Microgrid Stability



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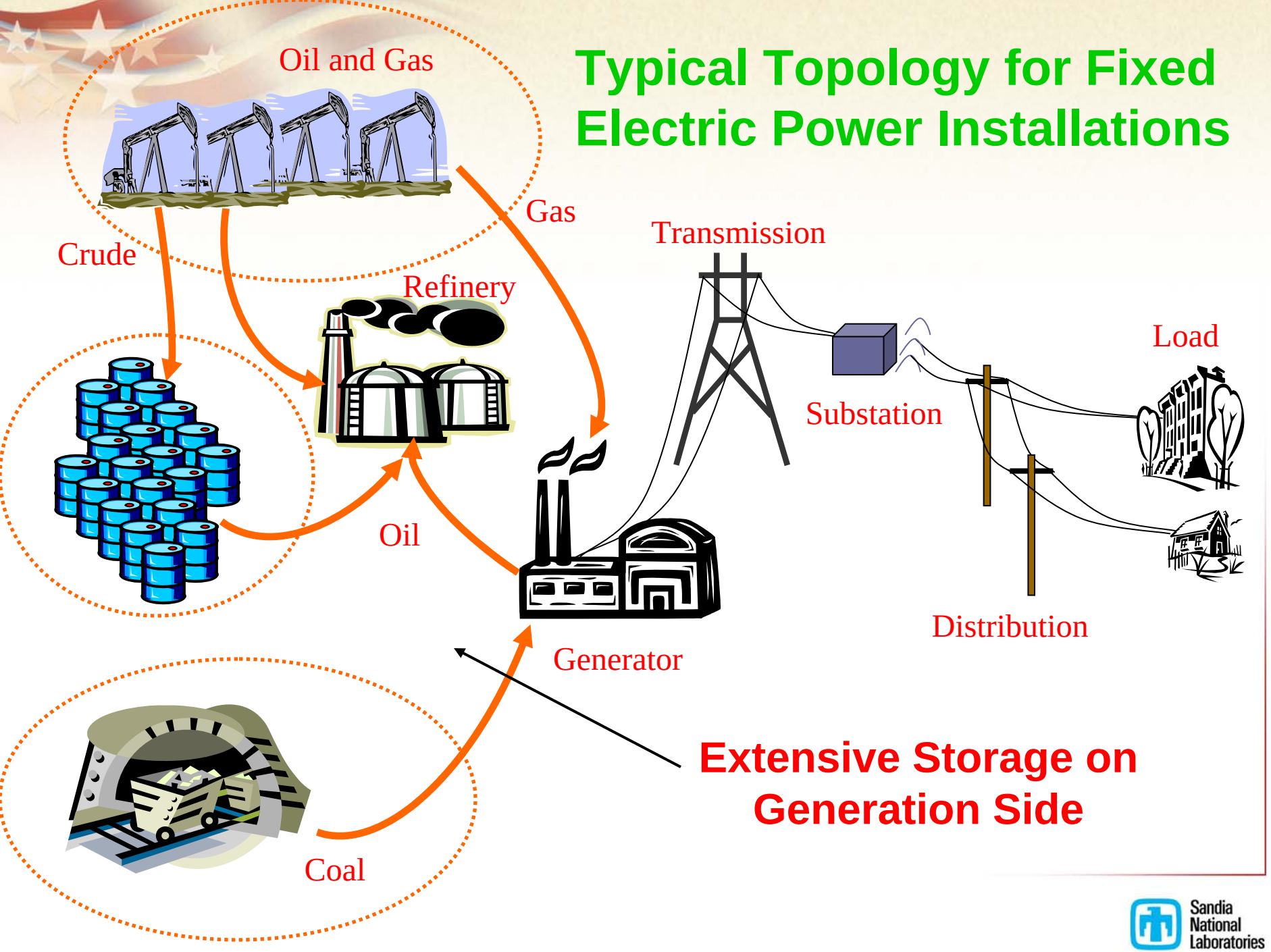
Typical Topology for Fixed Electric Power Installations



Extensive Storage on Generation Side

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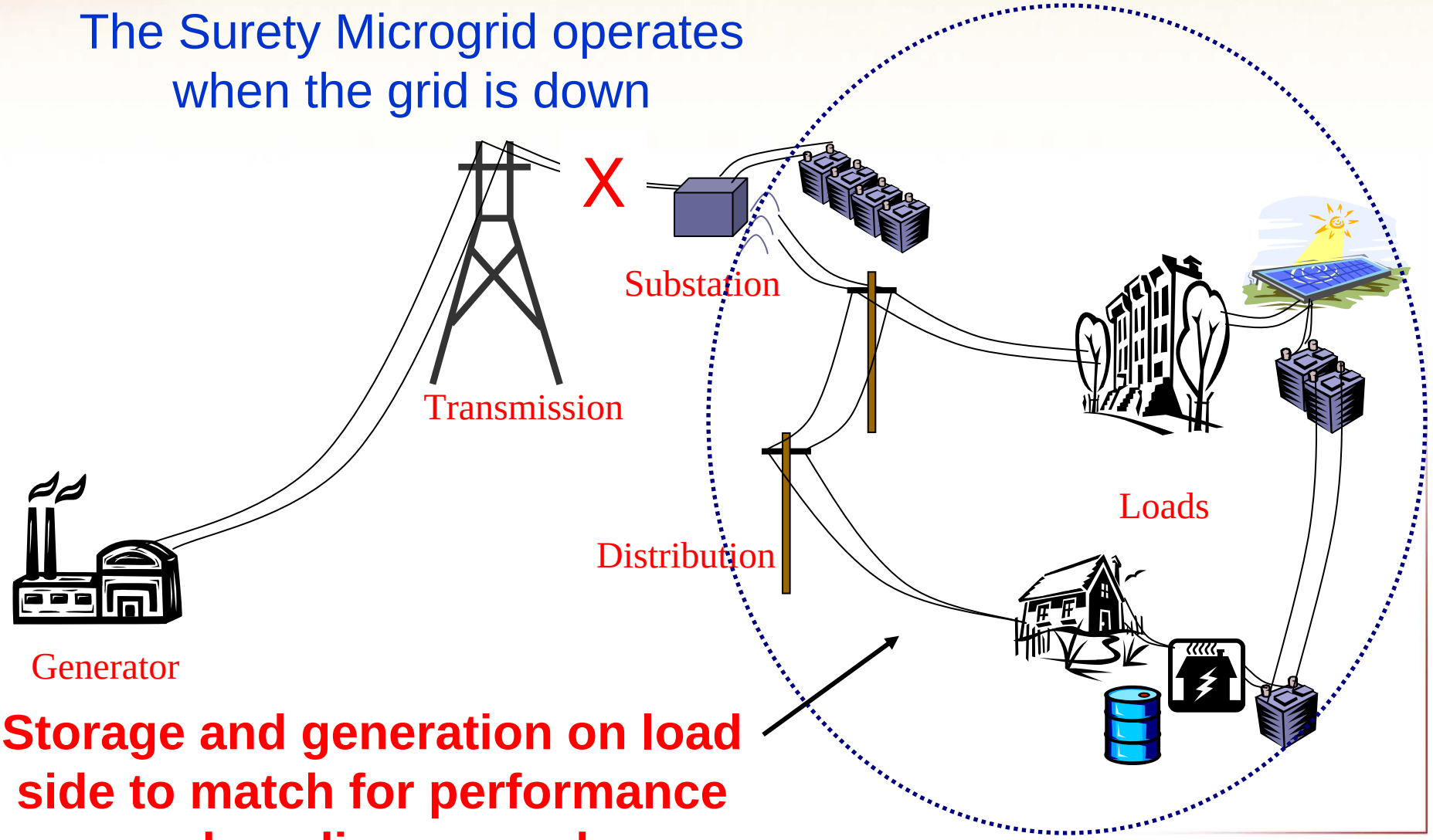
Energy Surety Microgrid

The Surety Microgrid operates when the grid is down



Storage and generation on load side to match for performance and readiness needs

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Energy Surety Approach
Improving Mission Readiness and Response

Energy Surety Elements	
Safety	Safely supplies energy to end user
Security	Maintains power in a malevolent environment
Reliability	Maintains power when and where needed
Sustainability	It can be maintained for mission duration
Cost Effectiveness	Produces energy at lowest predictable cost

Distributed Energy Infrastructures are Hard to Protect

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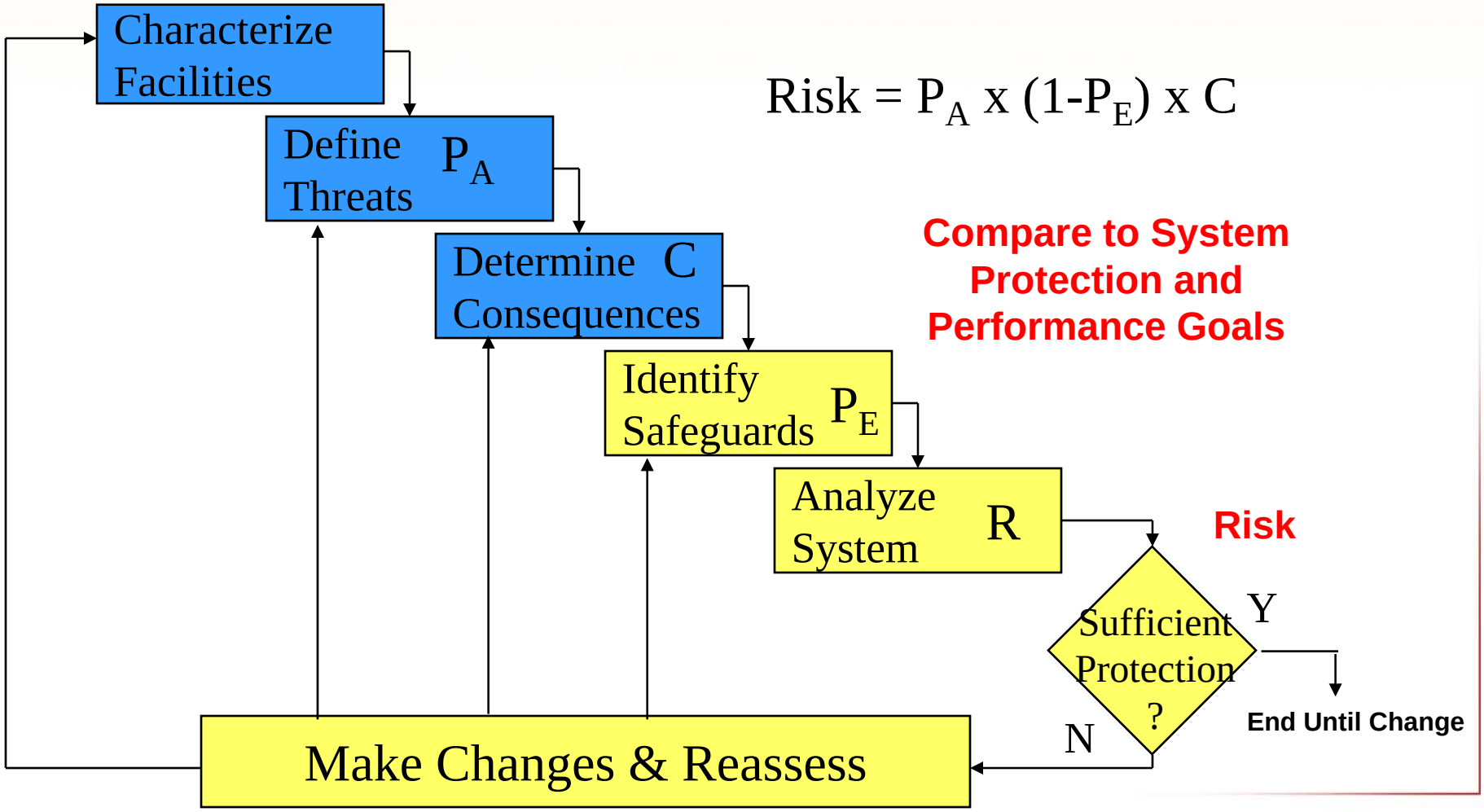
Risk-based Assessment Approach for Energy Systems



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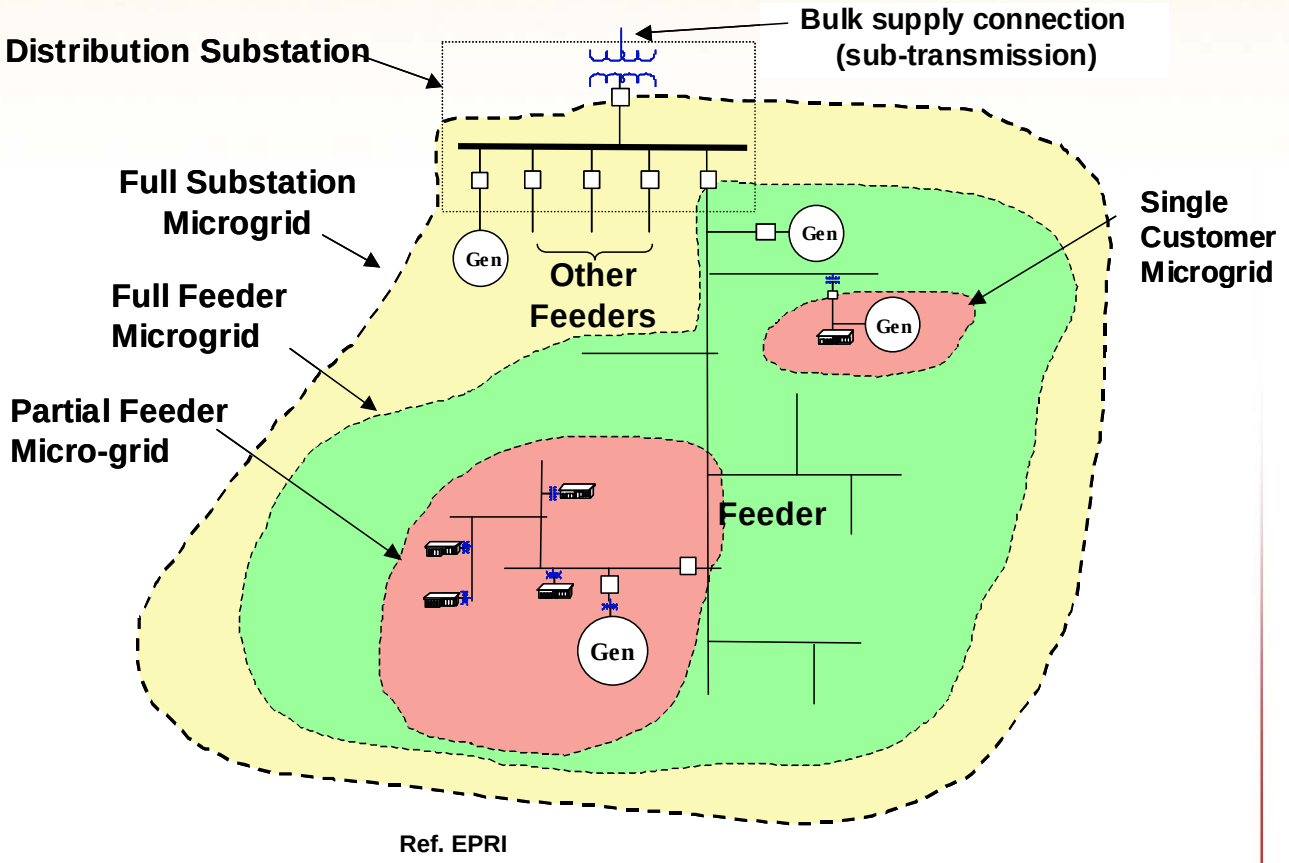
Distributed Generation and Microgrids

- Small combustion and µ-turbines
- Fuel cells
- IC engines
- Small hydro and wind
- Solar electric
- Energy storage (batteries, flywheels,…)
- Emerging plug in hybrid vehicles
- Landfill gas, waste to energy
- Energy efficiency improvements



Ref. EPRI

Residential	Less than 10-kW, single-phase
Small Commercial	From 10-kW to 50-kW, typically three phase
Commercial	Greater than 50-kW up to 10MW

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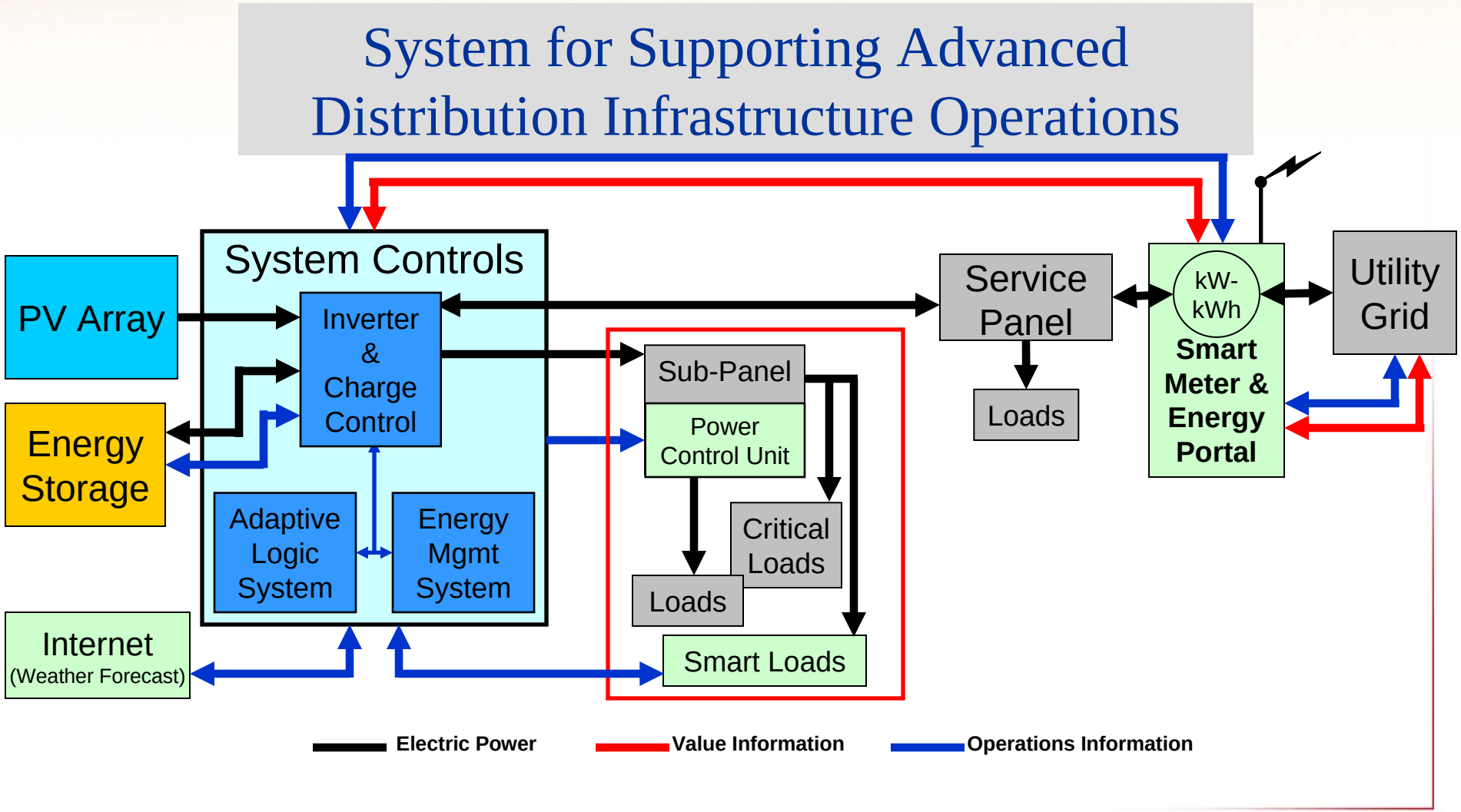
Complexity of Microgrid with Intelligence and Control



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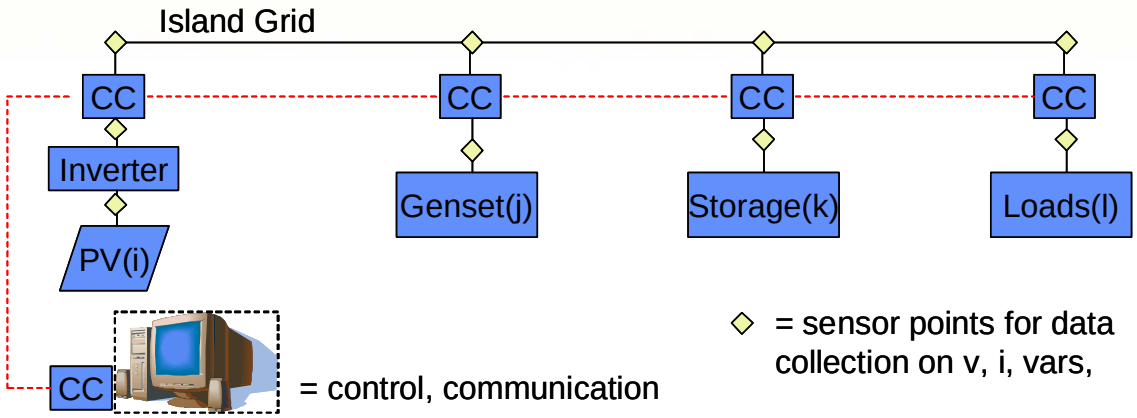
Energy Surety Microgrid Approach and Benefits

- Methodology that identifies benefits of increased energy supply reliability within base critical mission context
- Supports critical mission readiness
- Reduces dependence on fossil fuels – permits integration of renewables into power supply infrastructure
- Graphically illustrates the effect of energy improvements on critical mission capability based on condition and availability of power at critical facilities
  - Different from stating 9's of reliability – which does not factor in the erosion of critical mission capability

Simulating Real-World Microgrids at DETL
Example: Hawaiian Island of Lanai



Characteristics:

- **5MW grid; diesel-based**
- **1.5MW PV recently purchased**
- **2 large resorts are main loads, plus 1200 homes**

Issues being addressed:

- **Moving from diesel-based to 100% renewable grid**
- **Optimal amount/location of storage**
- **Distributed control algorithms**
- **Load management**

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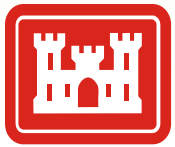
Application of an Energy Surety Microgrid for the Army



US Army Corps of Engineers

- Army Construction Engineering Research Lab (CERL)
  - Army perspective, Consequence Model development, Base selection and interface w/candidate Base, Roll-out Energy Surety Microgrid to Army/DoD complex
  - Ft. Sill, OK, proactively volunteered to be the first base from a competition of four Army Bases

- New Mexico State University:
  - Optimization of energy and fuel storage

- Leveraging Other Unique Sandia Expertise:
  - NISAC/Sandia Infrastructure Modeling provides Consequence Model
  - Sandia Intelligent Agents work develops advanced controls for DG sources in Energy Surety Microgrid

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Ft. Sill Evaluation of Energy Surety Microgrid Approach

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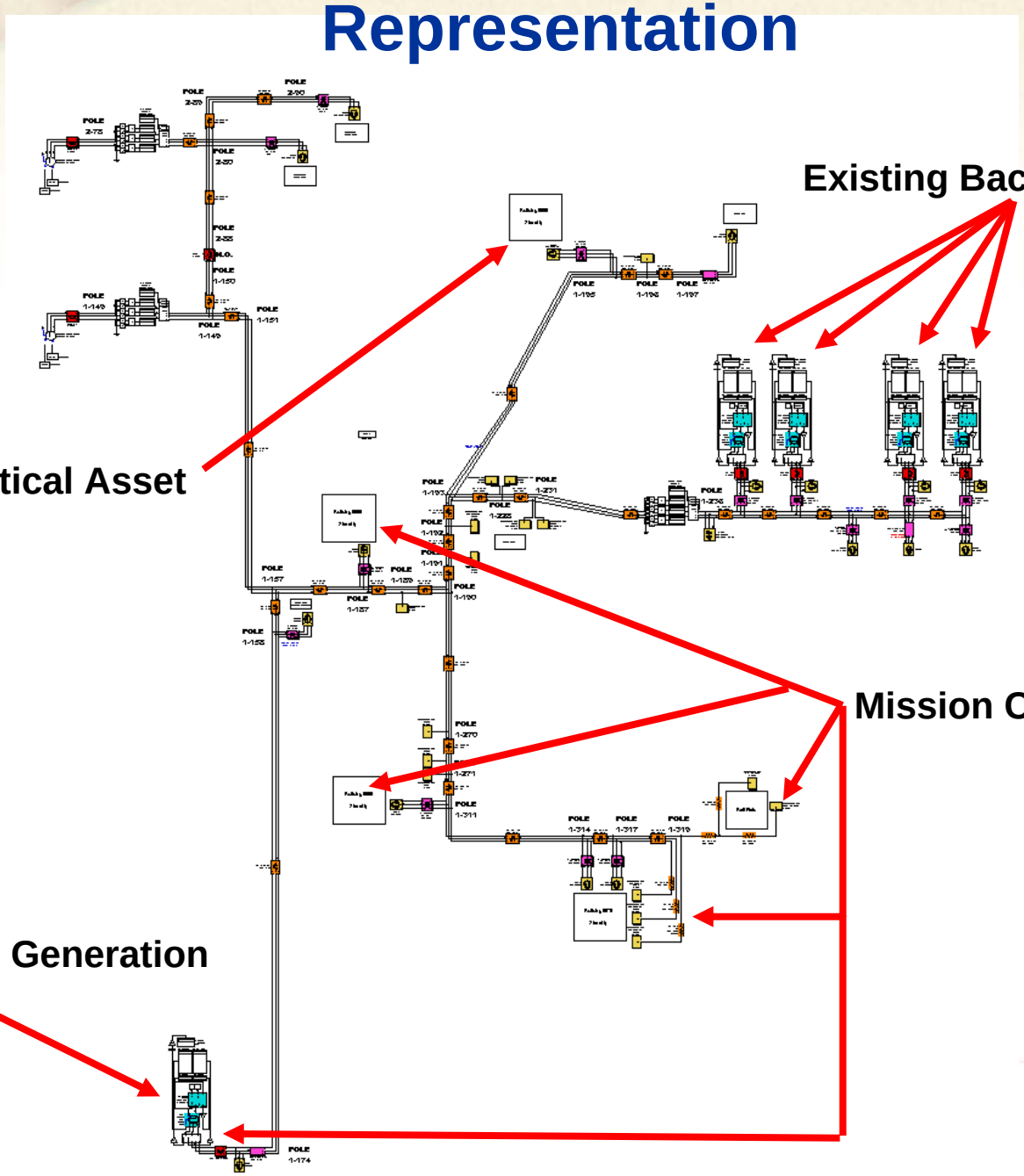
Ft. Sill Electric Distribution Representation



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Power Flow Model Outcomes

- **Model of existing distribution network, five backup generators and all Starship loads has been validated**

- **Model is ready to reconfigure the existing system into an Energy Surety Microgrid to meet Ft. Sill critical mission requirements**
  - **Locate and size new Distributed Generation (DG) and energy storage sources**
  - **Meet both electric and heat load requirements**

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